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(54) **ACOUSTIC SENSING SYSTEM FOR A MOTOR VEHICLE**

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G10K 11/178	(2006.01)

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CPC ***G01H 1/00*** (2013.01); ***G01H 11/06*** (2013.01); ***G10K 11/1788*** (2013.01); *G10K 2210/1282* (2013.01); *G10K 2210/3226* (2013.01)

(58) **Field of Classification Search**

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See application file for complete search history.

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(57) **ABSTRACT**

An acoustic sensing system for a motor vehicle includes a strain gauge mounted at a motor vehicle surface, and a sensing circuit operatively coupled to the strain gauge. The sensing circuit is configured and disposed to detect acoustic responses in a passenger compartment of the motor vehicle through the strain gauge.

23 Claims, 2 Drawing Sheets

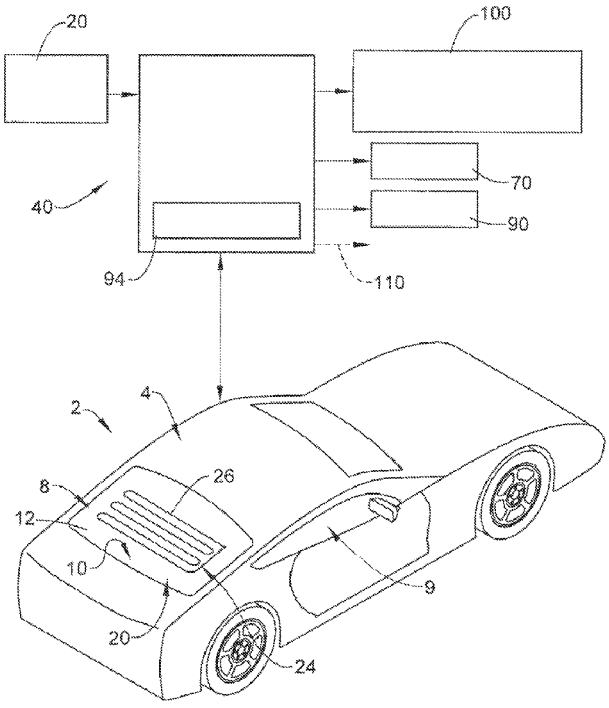


FIG. 1

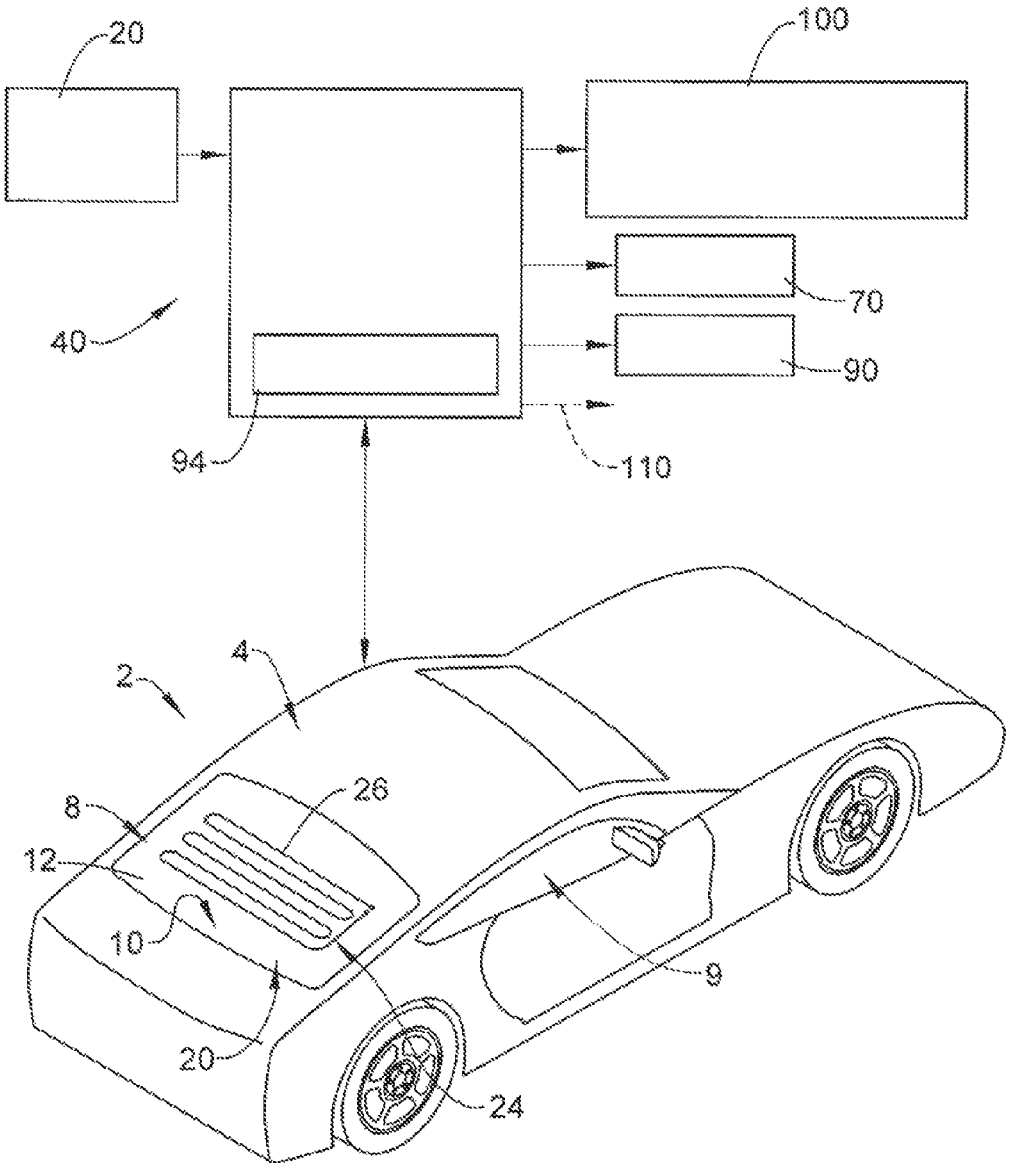
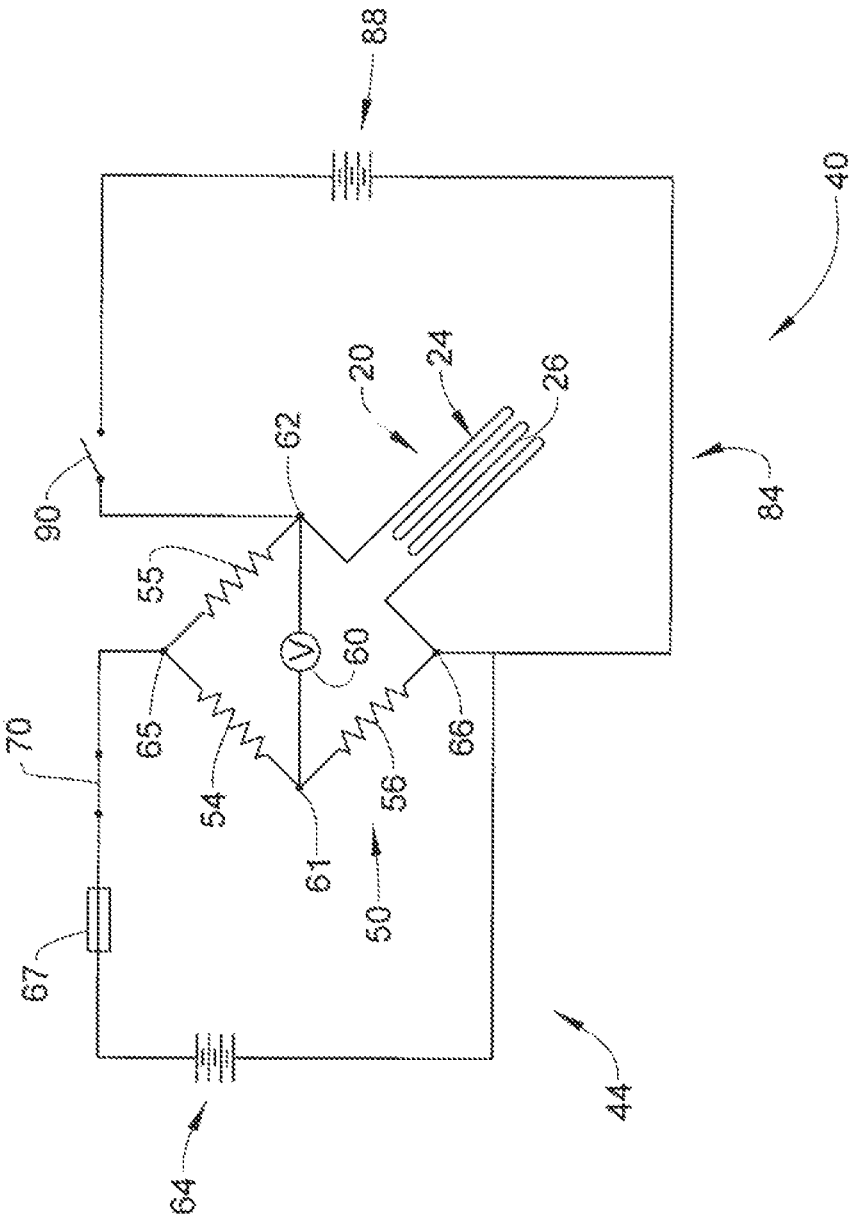


FIG. 2



ACOUSTIC SENSING SYSTEM FOR A MOTOR VEHICLE

FIELD OF THE INVENTION

The subject invention relates to motor vehicles and, more particularly, to an acoustic sensing system for a motor vehicle.

BACKGROUND

Motor vehicles include a passenger compartment that provides seating for a driver and one or more passengers. While traveling, the motor vehicle may pass over road surface imperfections such as pot holes, bumps, debris and railroad or trolley tracks or other objects that cause a physical and an audible response. In addition to road induced noise, engine noise and audio system noise may also represent unwanted or undesirable audible responses. The audible response(s) may pass through the motor vehicle into the passenger compartment as unwanted noise. The unwanted noise may be both perceived and annoying to the driver and/or the one or more passengers. In order to reduce the unwanted noise from passing into the passenger compartment, motor vehicles include a suspension system.

The suspension system may include one or more of a shock absorber system, a spring system, torsion bars, and the like, that dampen both the physical and audible response. While reducing effects of passing over changes in road surface, an audible response may still be perceived in the passenger compartment. In some cases, the suspension system itself contributes to the audible response. Accordingly, it is desirable to provide a system that can reduce unwanted acoustics that may be present in the passenger compartment of a motor vehicle.

SUMMARY OF THE INVENTION

In accordance with an exemplary embodiment, a passenger compartment acoustic sensing system for a motor vehicle includes a strain gauge mounted at a motor vehicle surface, and a sensing circuit operatively coupled to the strain gauge. The sensing circuit is configured and disposed to detect acoustic responses in a passenger compartment of the motor vehicle through the strain gauge.

In accordance with another exemplary embodiment, a motor vehicle includes a body having at least one motor vehicle surface that defines, at least in part, a passenger compartment. A passenger compartment acoustic sensing system is operatively coupled to the body. The passenger compartment acoustic sensing system includes a strain gauge mounted at the at least one motor vehicle surface, and a sensing circuit operatively coupled to the strain gauge. The sensing circuit is configured and disposed to detect acoustic responses in a passenger compartment of the motor vehicle.

In accordance with yet another exemplary embodiment, a method of sensing an acoustic response in a passenger compartment of a motor vehicle includes passing an electrical current through a strain gauge mounted at a surface of the passenger compartment, receiving an acoustic response through the strain gauge, and detecting the acoustic response with a sensing circuit electrically connected to the strain gauge.

The above features and advantages and other features and advantages of the invention are readily apparent from the following detailed description of the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features, advantages and details appear, by way of example only, in the following detailed description of embodiments, the detailed description referring to the drawings in which:

FIG. **1** is a schematic view of a motor vehicle including a passenger compartment acoustic sensing system in accordance with an exemplary embodiment; and

FIG. **2** is a schematic diagram illustrating the acoustic sensing system of FIG. **1**.

DESCRIPTION OF THE EMBODIMENTS

The following description is merely exemplary in nature and is not intended to limit the present disclosure, its application or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features. A motor vehicle, in accordance with an exemplary embodiment, is indicated generally at **2** in FIG. **1**. Motor vehicle **2** includes a body **4** having a plurality of motor vehicle surfaces, indicated generally at **8** that define, at least in part, a passenger compartment **9**. Motor vehicle surfaces **8** include at least one glass surface **10** that takes the form of a rear window **12** of motor vehicle **2**. Rear window **12** includes a strain gauge **20** shown in the form of an electric resistive heater **24**. Strain gauge **20** functions, in accordance with one aspect of the exemplary embodiment, as a rear window defroster **26**. As will be detailed more fully below, strain gauge **20** also forms part of a passenger compartment acoustic sensing system **40** that detects sounds, such as road noise, engine noise, audio system noise and the like that may be perceived within passenger compartment **9**.

In accordance with an exemplary embodiment, passenger compartment acoustic sensing system **40** includes a sensing circuit **44**, FIG. **2**, operatively connected to strain gauge **20**. Sensing circuit **44** includes a resistor bridge **50** having a first resistor **54**, a second resistor **55** and a third resistor **56**. Strain gauge **20** defines a fourth resistor. A volt meter **60** is electrically connected between a first junction **61** joining first and third resistors **54** and **56** and a second junction **62** joining second resistor **55** and strain gauge **20**. A voltage source **64** is connected between a third junction **65** joining first and second resistors **54** and **55** and a fourth junction **66** joining third resistor **56** and strain gauge **20**. Sensing circuit **44** also includes a current limiting device **67** and a switch **70** electrically connected in series between voltage source **64** and third junction **65**. Motor vehicle **2** also includes a defroster circuit **84** connected to strain gauge **20**. Defroster circuit **84** includes a voltage source **88** connected between second junction **62** and fourth junction **66**. Defroster circuit **84** also includes a switch **90**. Voltage source **88** may be the same as voltage source **64** or may be a separate source of electrical input.

In further accordance with the exemplary embodiment, passenger compartment acoustic sensing system **40** includes a controller **94** operatively connected between strain gauge **20**, switch **70** and switch **90**. Controller **94** selectively closes switch **70** and opens switch **90** during acoustic sensing. In this manner, higher currents associated with operating in a defrosting mode are not passing through first, second and third resistors **54-56**. When operating in an acoustic sensing mode, sounds transmitted through body **4** into passenger compartment **9** results in an acoustic response causing a change in resistance to strain gauge **20**. The change in resistance is sensed by volt meter **60** and passed to controller **94**. Controller **94** will signal an active acoustic cancellation system **100** to create and issue an acoustic cancellation signal,

cancelling the sounds causing the acoustic response in strain gauge **20**. In this manner, passenger compartment acoustic sensing system **40** enhances an overall driver and passenger experience with motor vehicle **2**.

At this point it should be understood that the exemplary embodiments provide a system for detecting undesirable acoustic and/or passenger compartment structural responses in a passenger compartment of a motor vehicle. The system is described as employing a rear window defroster as a strain gauge for sensing acoustic responses. It should be understood however that a separate strain gauge could be provided in the motor vehicle on any one of a number of surfaces including both glass and non-glass motor vehicle surfaces. Further, the controller could be provided with an additional output, such as shown at **110** that could signal an external or remote monitoring system of a motor vehicle event causing, for example, a break, crack and/or shattering of the rear window. The external monitoring system may take action to address the motor vehicle event.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the application.

What is claimed is:

1. An acoustic sensing system for a motor vehicle comprising:

a strain gauge mounted at a glass surface of the motor vehicle; and

a sensing circuit operatively coupled to the strain gauge, the sensing circuit being configured and disposed to detect acoustic responses in a passenger compartment of the motor vehicle.

2. The acoustic sensing system for a motor vehicle according to claim **1**, wherein the glass surface forms a rear window of the motor vehicle.

3. The acoustic sensing system for a motor vehicle according to claim **2**, wherein the strain gauge comprises a rear window defroster.

4. The acoustic sensing system for a motor vehicle according to claim **1**, wherein the strain gauge comprises an electric resistive heater.

5. The acoustic sensing system for a motor vehicle according to claim **4**, further comprising: a defroster circuit operatively connected to the electric resistive heater.

6. The acoustic sensing system for a motor vehicle according to claim **5**, further comprising: a controller operatively connected to the sensing circuit and the defroster circuit, the controller being configured and disposed to selectively electrically connect power to one of the sensing circuit and the defroster circuit and electrically isolate power from the other of the sensing circuit and the defroster circuit.

7. The acoustic sensing system according to claim **1**, wherein the sensing circuit is configured and disposed to detect breakage of the glass surface.

8. The acoustic sensing system for a motor vehicle according to claim **1**, further comprising: an active acoustic cancellation system operatively connected to the sensing circuit, the active acoustic cancellation system being configured and disposed to acoustically cancel the acoustic response in the passenger compartment.

9. A motor vehicle comprising:

a body including at least one glass surface that defines, at least in part, a passenger compartment; and

an acoustic sensing system operatively coupled to the body, the acoustic sensing system including:

a strain gauge mounted to the at least one motor vehicle glass surface; and

a sensing circuit operatively coupled to the strain gauge, the sensing circuit being configured and disposed to detect acoustic responses in a passenger compartment of the motor vehicle.

10. The motor vehicle according to claim **9**, wherein the glass surface forms a rear window of the motor vehicle.

11. The motor vehicle according to claim **10**, wherein the strain gauge comprises a rear window defroster.

12. The motor vehicle according to claim **9**, wherein the strain gauge comprises an electric resistive heater.

13. The motor vehicle according to claim **12**, further comprising: a defroster circuit operatively connected to the electric resistive heater.

14. The motor vehicle according to claim **13**, further comprising: a controller operatively connected to the sensing circuit and the defroster circuit, the controller being configured and disposed to selectively electrically connect power to one of the sensing circuit and the defroster circuit and electrically isolate power from the other of the sensing circuit and the defroster circuit.

15. The motor vehicle according to claim **9**, wherein the sensing circuit is configured and disposed to detect breakage of the glass surface.

16. The motor vehicle according to claim **9**, further comprising: an active acoustic cancellation system operatively connected to the sensing circuit, the active acoustic cancellation system being configured and disposed to acoustically cancel the acoustic response in the passenger compartment.

17. A method of sensing an acoustic response in a passenger compartment of a motor vehicle, the method comprising:

passing an electrical current through a strain gauge mounted at a glass surface of the passenger compartment;

receiving an acoustic response through the strain gauge; and

detecting the acoustic response with a sensing circuit electrically connected to the strain gauge.

18. The method of claim **17**, wherein receiving the acoustic response through the strain gauge includes receiving an acoustic response through a rear window defroster mounted in the passenger compartment.

19. The method of claim **18**, further comprising: selectively operating the strain gauge in one of an acoustic sensing mode and a defrosting mode.

20. The method of claim **17**, further comprising: actively cancelling the acoustic response sensed through the strain gauge.

21. The method of claim **17**, wherein receiving the acoustic response through the strain gauge includes receiving an acoustic response through a glass surface of the motor vehicle.

22. The method of claim **21**, further comprising: detecting breakage of the glass surface.

23. The method of claim **22**, further comprising: signaling breakage of the glass surface to a remote monitoring system.

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